High prevalence of undernutrition among male brick kiln workers of Murshidabad District, West Bengal, India: A comparison of body mass index and mid-upper arm circumference

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Abstract: *Background:* Undernutrition among rural Muslim population, especially the brick-kiln-workers may be a major health problem in India. *Material and Methods:* A cross-sectional study of 505 male adult brick-kiln workers of Murshidabad district, West Bengal was conducted. The body mass index (BMI) and mid-upper-arm circumference (MUAC) were used to evaluate CED (BMI < 18.5 kg/m^2). To assess nutritional status and to compare the utility of two different anthropometric indicators of chronic energy deficiency (CED) among adult male brick-kiln workers. *Results and Conclusion:* BMI based prevalence of CED was 25.00% while under nutrition based on MUAC < 23.0 cm was 23.40%. Both these prevalence comes under the high-prevalence category (25.00%) indicating a serious situation according to World Health Organization recommendations. Among the low MUAC (<23.0 cm) individuals, the rate of CED was significantly (p<0.001, x^2 =169.40) higher (70.30%) than among normal MUAC ($\geq$ 23.0 cm) individuals (29.70%).This occupational group was facing severe nutritional stress. With limited resources and in the absence of skilled manpower, it may be more appropriate to use MUAC for human population surveys, particularly among adults of developing countries.
Keywords: Brick-kiln workers, Murshidabad, Body Mass Index (BMI), Mid-upper Arm Circumference (MUAC), Chronic Energy Deficiency (CED).

Introduction

Nutrition and health *are* the most important contributory factors for human resource development in the country [1]. Nutrition is concerned with social, economic, cultural and psychological implications of *the* food eaten. Under nutrition among adult population is a serious public health problem internationally, especially in developing countries. Malnutrition in adult population puts them at a high risk of decreased physical development and increased incidence of infectious diseases [2].

Though, anthropometry have some limitations, yet, it's remains the most practical tool for a rapid assessment of nutritional status at individual as well as community level, particularly in resource constrained circumstances in developing countries such as India. Body mass index (BMI) is widely accepted as one of the best indicators of nutritional status in adults [2]. Many studies have shown that BMI is a reasonable anthropometric measure of total body fat or storage of energy in the body [3-4]. Although adult nutritional status can be evaluated in several ways, the BMI is the most widely used because it is simple, inexpensive, safe and suitable for large scale surveys [5-8]. BMI reflects not only the nutritional status but also the socio-economic condition of a population, especially, the adult population in developing countries [6, 9-12]. A BMI<18.5 kg/m^2 is widely used as a practical measure of chronic energy deficiency (CED) i.e a 'steady' state of underweight in which an individual is in an energy balance irrespective of a loss in body weight or body energy stores [13]. Such a 'steady' underweight is likely to be associated with morbidity or other physiological and functional impairments [2, 9, 14]. CED is caused by inadequate intake of energy accompanied by high level of physical activities and infections for a considerably long period of life [9]. It is associated with reduced work capacity (Pryer, 1993; Durnin, 1994) [15-16] poor work performance and productivity [17] increased morbidity due to suppressed immune function [9, 18] and behavioral changes [19].

On the other hand, mid-upper arm circumference (MUAC) is another anthropometric measure used to evaluate adult nutritional status [7]. It is simpler measure than BMI, requires minimum equipment and may predict morbidity and mortality as accurately as underweight [20]. An extensive study using data from 8 countries (Mali, India, Senegal, Zimbabwe, Somalia, Ethiopia, Papua New Guinea and China) suggested that MUAC could be used as a simple screening tool for assessment of nutritional status. MUAC has been suggested as a substitute for BMI when the rapid screening of an adult population is required as a prelude to targeting the provision of assistance to those who are undernourished [7].

Until recently, there has been little attempt to assess the prevalence of under-nutrition among adults living in developing countries despite the widespread concern about world hunger and food insecurity [21]. In spite of the economic development in the region, undernutrition remains an important public problem in many Asian countries [22]. India being one of the poorest countries in the world and adopting several recent community level measures to lift up the nutritional status of its people, improvements during the last two to decades have not been impressive [21]. More than half of the world's undernourished people lived at the end of 20th century in India [23].

The brick field industry is one of the oldest industries in West Bengal. Assessment of occupational health problems is one of the common fields in study of ergonomics. The industry has an annual turnover of more than 10000 crores and it is one of the largest employment generating industries [24]. In many developed countries some mechanization has been introduced but in India the conditions have not improved and human drudgery still prevails. Several studies showed that the workers working in the brick manufacturing units suffered from musculoskeletal problems due to awkward working postures [25-27]. Brick workers are known for poor health and poor access to health care. The brick-kiln worker's are living in poor environment adjoining brick making

units. They have poor access to health care. They are at risk of various types of illnesses. Work related illnesses are very common among the brick-kiln workers leading to loss of job and earning [28].

Information on nutritional status of brick-kiln workers, nevertheless, is extremely scanty and there is no study from West Bengal which has utilized BMI and MUAC together to assess undernutrition. In view of this context, the present study was conducted to report the prevalence of CED as well as undernutrition based on MUAC cut off value among adult male brick-kiln workers of Murshidabad District in West Bengal.

Material and Methods

The present study was conducted in twelve brick fields in the Rejinagar area of Beldanga block of Murshidabad district, West Bengal. These brick fields are located 30 km from Murshidabad district town, which is approximately 195 km from Kolkata the state capital of West Bengal. Since this study was aimed at adult males (18-59 years), all adult male residents in the nearer villages of the brick field area. This cross-sectional study sample included 505 adult male and data were collected in the years 2014 to 2016. The response rate was little below 75%.The vast majority of the subjects were illiterate and earning very low wages. Thus, they belonged to the low socioeconomic class.

Ethical considerations were guided by the Helsinki Declaration [29]. Ethical approval and prior permission was obtained from Vidyasagar University and Brick Owner Association, respectively, before commencement of the study. Informed oral consent was also obtained from each participant. Information on age, occupation and educational status was obtained from all subjects with the help of a questionnaire. The first Author (MG) took anthropometric measurements following the standard techniques of Lohman [5]. Both height and mid-upper arm circumference were recorded to the nearest 1 mm and weight to nearest 500 g. BMI was computed as weight (kg)/ Height (m^2).

Nutritional status was evaluated using internationally accepted BMI guidelines of World Health Organization as follow: [2]

1) CED   : BMI<18.5 kg/m^2
2) Normal   : BMI=18.5-24.99 kg/m^2
3) Overweight: BMI$\geq$25.0 kg/m^2

We followed the World Health Organization's classification [2] of the public health problem of low BMI, based on adult populations worldwide. This classification categorizes prevalence according to percentage of a population with BMI< 18.5 kg/m^2.

1) Low (5-9%): warning sign, monitoring required.
2) Medium (10-19%): poor situation.
3) High (20-39%): serious situation.
4) Very high ($\geq$40%): critical situation.

Mid-upper arm circumference (MUAC) can be used for evaluating nutritional status studies among third world adults. The following cut-off points were used:

Nutritional Status	Among Men
Under-nutrition	MUAC < 23.0 cm
Normal	MUAC $\geq$ 23.0 cm

Mean and Standard Deviation were calculated to describe the age and anthropometric parameters. Percentage was used to calculate the prevalence rates. Chi square statistics was used to assess the significance of differences in prevalence rates between groups. Odds ratio (OR) with its 95% confidence interval (95% CI) was also calculated to estimate the likelihood of occurrence of certain condition, e.g., undernutrition. All statistical analyses were undertaken using the SPSS statistical package, statistical significance was set at p<0.05.

Results

Table-1: Age and anthropometric characteristics of the subjects	
Variable	**Mean ±SD**
Age (years)	36.50 ± 11.59
Weight (kg)	54.01 ± 7.20
Height (cm)	163.83 ± 5.89
MUAC (cm)	24.53 ± 2.07
BMI (kg/m^2)	20.11 ± 2.39

Table 1 shows the anthropometric characteristics of the subjects. The mean and standard deviation values of age, weight, height, MUAC and BMI were 36.50 ± 11.59 years, 54.01 ± 7.20kg, 163.83 ± 5.89 cm, 24.53 ± 2.07 cm and 20.11 ± 2.39 kg/m^2, respectively. *Table 2* present**s** the nutritional status of the subjects based on BMI. Overall the extent of malnutrition was 29.8; among them 25.0% were undernourished. The rates of CED-Grades III, II and I were 1.4%, 4.4% and 19.2%, respectively.

Table-2: Nutritional status of the subjects based on body mass index (BMI)			
BMI(kg/ m^2)	**Category**	**Frequency**	**Percentage (%)**
< 16.0	CED Grade-III	7	1.4
16 – 16.99	CED Grade-II	22	4.4
17 – 18.49	CED Grade-I	97	19.2
18.5 - 24.99	Normal	355	70.3
$\geq$25.0-29.99	Overweight	23	4.6
$\geq$ 30.0	Obese	1	0.2
Total		505	100

Table 3 presents the nutritional status of the subjects based on MUAC. The rates of under-nutrition are 23.4% and normal is 76.6%. It is nearest to the rates of low BMI (25.0%). *Table 4* shows the relationship between prevalence of CED and undernutrition assessed by BMI and MUAC, respectively. Overall 23.4% under-nutrition based on MUAC and 25.0% under-nutrition based on BMI. Among the low MUAC (<23 cm) individuals, the rates of under-nutrition is greater than that of normal MUAC (70.3% vs 29.7%) based on BMI. This low MUAC was statistically highly significant (x^2=169.40, p<0.001,) with low BMI. The result reveals that low MUAC had 2.99 fold greater risk for CED.

Table-3: Nutritional status of the subjects based on Mid-upper arm circumference (MUAC)

MUAC (cm)	Category	Frequency	Percentage (%)
<23.0	Under-nutrition	118	23.4
≥23.0	Normal	387	76.6
Total		505	100

Table-4: Relationship between body mass index (BMI) and mid-upper arm circumference (MUAC)

Nutritional Status by BMI (row) and MUAC (column)	Under-nutrition BMI < 18.5 kg/m² (n, %)	Normal BMI ≥ 18.5kg/m² (n, %)	Total (n, %)
Under-nutrition (MUAC <23cm)	83 (70.3%)	35 (29.7%)	118 (23.4%)
Normal (MUAC≥23 cm)	43 (11.1%)	344 (88.9%)	387 (76.6%)
Total	126 (25.0%)	379 (75.0%)	505 (100%)
Chi-square =169.40, p <0.0001. OR=2.99 (95%CI: 2.265-3.965)			

Discussion

Several recent studies from India have utilized BMI to study under-nutritional status of adult populations [30-34]. Therefore, the use of BMI and its cut-off points recommended by WHO for the evaluation of CED are valid for use among adult populations of India. The economic and health burden of high frequencies of adult CED has been well documented [6, 7, 13, 35].

The functional and economic significance of a high prevalence of CED has already been established [6]. Therefore, efforts must be made to investigate the consequences of the functional impairments commonly associated with low BMI in various ethnic groups. It is also essential to ascertain the relationship of the high prevalence of under-nutrition with morbidity and mortality among adults. The outcome of the present study clearly indicated that the prevalence of CED among adult male brick-kiln workers was high on the basis of either BMI (25.0%) or MUAC (23.4%). Both of these percentages are greater than 20% placing the population in the serious situation according to WHO recommendation. *Table 5* presents the mean age, height, weight and BMI prevalence among adult brick-kiln workers of India [36-37]. The mean height, weight and BMI ranged from 149.0 to 169.0 cm, 39.6 to 55.2 kg and 18.4 to 19.54 kg/m² respectively. Low mean height, weight and BMI were found among the female workers of Hooghly and 24 Parganas of West Bengal.

Table-5: Mean age, height, body weight and body mass index (BMI) among various brick-kiln workers of India

Study Area	Sex	Sample Size	Mean age (year) ±SD	Mean Height (cm) ±SD	Mean Weight (kg) ±SD	Mean BMI (kg/m^2) ±SD	Reference
Hooghly, West Bengal	Male	220	33.5±6.2	169.2±4.1	55.2±6.2	18.8±1.8	Das (2014) [36]
Hooghly & 24 p (s), West Bengal	Female	55	24.4±4.16	149.0±4.62	39.6±3.44	17.9±1.80	Bandyopadhyay & Sen (2014) [37]
Murshidabad,West Bengal.	**Male**	**505**	**36.5±11.59**	**163.8±5.89**	**54.0±7.20**	**20.1±2.39**	**Present Study**

Table-6: Prevalence of CED (based on BMI) among brick-kiln workers of India

Study Area	Sex	Sample Size	CED (%)	Reference
Hooghly & 24 p (s), West Bengal	Female	55	58.0%	Bandyopadhyay & Sen (2014) [37]
Thane, Mumbai.	Male	86	44.6%	Shewale et al (2013) [38]
Murshidabad, West Bengal.	Male	505	25.0%	Present Study

High rates of CED have also been reported from other brick-kiln area of India. *Table 6* present the high rates of CED prevalence among the adult brick-kiln workers of India [37-38]. The rates of CED range from 25.0% to 58.0%; these values are classified as high (20% - 39%) to very high (≥40%) rates according to WHO (1995). Among them, the rates of CED were very high among the adult female worker (58.0%) of Hooghly and 24 *P*arganas (s) of West Bengal. These results clearly indicated that both adult male and female of this occupational group were under serious or critical nutritional stress.

In the present study, the prevalence of undernourished individuals (MUAC< 23 cm) was significantly higher among the CED individuals (Chi-square=169.40, p<0.001), which indicated that these measures were well correlated. This implies that both these measures could be used to evaluate nutritional status among adult male brick-kiln workers. However, the difference in the prevalence of CED according to the two measures may have public health implications, especially in large population surveys. Moreover, as MUAC is much easier to measure than BMI [2, 39], the use of MUAC should be preferred in large scale studies. Therefore, with limited resources and in the absence of skilled manpower, it may be appropriate to the use of MUAC for human population's survey, especially among rural population of developing countries. Thus, although both BMI and MUAC could be used to evaluate nutritional status, MUAC may be preferred for its simplicity.

However, it must be mentioned here that some limitations of the present study were the small sample size and the non-availability of data on dietary intake. From the public health perspectives of paramount importance is the immediate initiation of appropriate nutritional intervention programmers among this occupational group.

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